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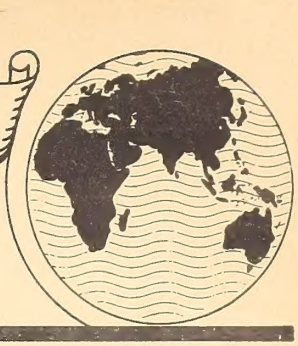

CACAO CULTIVATION

AND

IMPROVEMENT PROGRAMS

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by

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CACAO CULTIVATION AND IMPROVEMENT PROGRAMS

HISTORICAL BACKGROUND

Cacao is native to the New World. Neither the tree nor its produce was known in Europe until after the discovery of America. When Cortez conquered Mexico, he found the Indians preparing a nourishing beverage from cacao beans and also using them as a medium of exchange, so highly were they prized. The Indians held the cacao tree as sacred. According to their mythology, the seeds were brought from heaven by an Indian prophet, Quetzalcoatl, so that the first "Sons of the Sun" might enjoy a food previously reserved for the gods. In naming the plant *Theobroma*, which means food of the gods, Linnaeus, the great Swedish botanist, used terminology which perpetuates the ideas of the early Mexican Indians.

Cacao beans were sent to Spain, but they remained a curiosity until it was learned that a delicious drink could be prepared from them by adding sugar, vanilla, and cinnamon. The Spaniards then recognized their commercial possibilities. They introduced cacao cultivation into Trinidad, Haiti, and other West Indian islands; the Celebes in the East Indies; Fernando Po (just off the west coast of Africa); and the Philippine Islands. The Indians in Ecuador, Venezuela, and Central America already had been growing cacao for uncounted decades.

For many years the Spaniards kept secret the method of chocolate preparation, but eventually the information leaked out and spread over Europe. By the middle of the seventeenth century, chocolate had become a fashionable drink in most major European cities, but consumption increased slowly until the latter half of the nineteenth century.

Two events largely accounted for the expansion of the chocolate industry in the nineteenth and twentieth centuries. In 1828, C. J. van Houten, a Dutch manufacturer, discovered a method of preparing cocoa powder, as we know it today, by extracting a part of the fat or cocoa butter. Prior to that time, the beverage had been made from chocolate which contained most of the cocoa butter. This beverage, made from whole chocolate, was very nourishing but extremely rich and did not meet with the approval of all consumers. Cocoa powder, however, produced a lighter and more universally acceptable drink, which rapidly gained in popularity. The cocoa butter which resulted from van Houten's process remained an unimportant byproduct until the "discovery" of milk chocolate.

In 1876, Daniel Peter of Vevey, Switzerland, began the manufacture of milk chocolate on a commercial scale by combining powdered milk with chocolate liquor. Present-day manufacturing methods vary. Some manufacturers use fresh milk, some condensed milk, and others milk powder. But whatever the means of preparation, milk chocolate has grown in favor until today 50 percent, or more, of the chocolate consumed is in this form. Once consumers became accustomed to the smoothness of milk chocolate, they demanded the same quality in plain chocolate. Fondant chocolate was developed to meet this demand. It is made by adding additional quantities of cocoa butter to the chocolate and working the mixture in various machines until the desired texture

is obtained. Since both milk and fondant chocolate require the addition of large quantities of cocoa butter, this byproduct of the cocoa industry has become a vital necessity to the manufacturers of chocolate confectionery. No altogether satisfactory substitute has been found.

By a fortunate circumstance, just at the time when increased demand for chocolate products called for a larger supply of cocoa beans, a new producing area was coming into prominence. This was West Africa. According to the generally accepted story, a native of the Gold Coast returning from Fernando Po in 1879 carried with him some cacao pods. He planted some of the beans or seeds, and this was the beginning of the Gold Coast's giant industry. By 1915, the Gold Coast had become the world's largest exporter of cacao beans, and other countries of West Africa also were becoming important producers. The rapid expansion in cacao production after 1900 was due primarily to the contribution of West Africa.

The first steps in processing the beans into cocoa or chocolate products, although differing in minor details among the manufacturers, consist in roasting, crushing, and separating the shells or seed coats from the kernels. The broken angular fragments of kernels remaining after the shells are removed are called "cacao nibs." To make chocolate, the cacao nibs are ground. During the grinding process heat is generated, which melts the fat in the nibs, and a thick chocolate liquor emerges from the mill. This is pure chocolate or unsweetened commercial chocolate. To it may be added spices, flavoring, sugar, milk, etc., to produce the various chocolate products. After roasting, high-quality beans may be blended with those of lower quality to improve the flavor and color of the chocolate. As many as eight types of beans were used in a chocolate blend 20 or 30 years ago, whereas only three or four are used today. Most Americans prefer mild-tasting, light-colored chocolate in contrast to the Europeans who prefer a dark, somewhat bitter chocolate.

To make cocoa powder, about one-half the original fat content of the chocolate liquor is removed, and the remaining residual material is pulverized. Sugar, spices, or flavoring may then be added to produce the various brands of breakfast cocoa seen on grocers' shelves.

The fat or cocoa butter is used largely in the confectionery industry and to a lesser extent in the manufacture of tobacco, soap, and cosmetics. Cocoa press cake, a byproduct obtained when beans are processed to obtain the maximum amount of cocoa butter, is used in the manufacture of theobromine.

The shells or seed coats may be used as fertilizer, a source of theobromine and caffeine, and to a minor extent in prepared animal foods.

Botanical Description

The cacao tree is an evergreen belonging to the plant family Sterculiaceae, of which the most important commercial species is *Theobroma cacao* L. The mature tree is small, usually between 15 and 25 feet in height. It commonly has a long tap root with well-developed laterals, but root development is contingent to some extent upon the type of soil and the water level. Like most tropical trees, cacao puts forth new shoots several times each year. The new leaves are pale rose or yellowish green in color but soon change to light green and later to dark green. The small white or rose-colored flowers, somewhat star-shaped, are borne in little clusters on cushions which arise directly on the trunk and older branches. From these cushions a succession of flowers is produced for many years. Flowering may occur the year around in some varieties, but usually there are two periods when flowering is heaviest. This results in

two principal harvesting periods, known as the main and midcrops. The fruits or pods mature about 5 months after the flowers are pollinated.

Several thousand flowers are produced annually, but only a very small percentage ever mature fruits. The shape, dimensions, and color of the pods differ with the variety. In general, they are melon- or cucumber-shaped, 5 to 10 inches long by 3 to 5 inches in diameter, and red or yellow in color. Each fruit contains between 30 to 45 almond-shaped seeds, which when cured are the cacao beans of commerce.

Varieties and Commercial Types

About 20 species of cacao are known, but only one species, *Theobroma cacao* L. is cultivated widely. Although the vegetative and floral characters of this species are rather uniform throughout its range of distribution, two main groups of cacaos, Criollo and Forastero, are separated on specific differences in seed color and fruit forms. The Criollos are native to Central America, Colombia, and western Venezuela. The Forasteros occur in the Amazon and Orinoco River Basins. Introductions of Forastero into Criollo-producing countries have resulted in Criollo-Forastero crosses called Trinitarios or hybrid Forasteros.

Criollos produce fruits which are thin-walled, warty, conspicuously furrowed, and usually pointed. The fresh seeds are plump, either white or pale violet in color, and vary from sweet to slightly bitter in taste. When properly cured, Criollo beans produce high-quality chocolate and cocoa products.

The Forastero fruits are variously shaped, with smooth, thick, hard walls. The unroasted beans are flattened, bitter tasting, purple-colored and yield lower quality products than the Criollo. Forasteros are cultivated extensively in West Africa and Brazil, producing approximately 70 percent of the world's total supply of beans.

The Trinitario or hybrid-Forastero group produces a wide variety of pod forms. For convenience, the forms are grouped according to shape:

(a) Angoleta or Liso - Criollolike,
(b) Cundeamor or Cundeamor verrugosa - bottle-necked,
(c) Amelonado - melonlike, and
(d) Calabacillo - globular and smooth like a calabash squash.

Commercial cacaos are divided into flavor, or quality, types, and ordinary, or base, types. The flavor cacaos usually contain Criollo influence, but not necessarily. The ordinary cacaos are Forasteros with very little, if any, Criollo influence. Representative cacaos of each group are:

FLAVOR CACAOS		ORDINARY CACAOS	
Country	*Trade name*	*Country*	*Trade name*
Ceylon	Ceylon	Brazil	Superior Bahia, Ordinary Bahia, Para, Victoria
Colombia	Cauca		
Ecuador	Red Summer Arriba, Seasons Arriba, Machala	Costa Rica	Fermented Costa Rican
Grenada	Grenada Estates, Grenada Plantation	Dominican Republic	Sanchez
Java	Java	Gold Coast	F.F. Accra, Midcrop Accra

Mexico	Tabasco	Haiti	Haiti
Samoa	Samoa	Jamaica	Fermented Jamaica
Trinidad	Trinidad Estates, Plantation Trinidad	Nigeria	FAQ Lagos, Mid-crop Lagos
Venezuela	Maracaibo, Porto Cabello Caracas, Carupano, Trinidad Caracas	Panama	Fermented Panama
		Sao Tome	Fine Sao Tome

Climatic Requirements

In general, cacao may be cultivated in countries situated between latitudes 20° N. and 20° S. For best development it requires: A rich, humid, deep porous soil; an average atmospheric temperature of about 80° F.; and an evenly distributed annual rainfall, roughly between 60 and 150 inches. Cacao may be grown under irrigation. Ordinarily cacao does not thrive above a 2,000-foot elevation, but in the Cauca Valley of Colombia it grows successfully at an elevation of about 3,000 feet. The tree is particularly sensitive to wind and should have a sheltered location.

Cultural Practices

PLANTING AND MAINTENANCE. - After clearing the land of forests or brush, and effecting drainage where necessary, provision is made for temporary shade before planting either singly or in a mixture of the following: Tannia (species of *Xanthosoma* and *Colocasia*), bananas or plantains (*Musa* sp.), yuca or cassava (*Manihot* sp.), castor-oil plant (*Ricinus communis*), pigeonpea (*Cajanus indicus*), and corn (*Zea mays*) These plants provide the farmer with a cash income until the cacao trees come into bearing.

In most countries permanent shade for cacao trees is recommended. Trees commonly used for permanent shade are species of the coral tree or "Bois Immortelle" (*Erythrina*), Madre (*Gliricidia sepium*), Spanish cedar (*Cedrela odorata*), Leucaena (*Leucaena* sp.), saman (*Pithecolobium saman*), guamo (*Inga* sp.), and cashew (*Anacardium occidentale*). The kapok tree (*Ceiba pentandra*) and the rubbertree (*Hevea brasilensis*) are occasionally used.

After temporary shade is provided, the field is ready for planting the cacao. The seeds are either sown directly in the field or planted in nurseries and the seedlings transplanted. If available, rooted cuttings from superior trees are preferred. The planting distance varies from 6 to 20 feet with 12 feet being the most common. The trend now, however, is toward closer spacing, from 6 to 9 feet, with a minimum of shade.

It is desirable that cacao plantings be weeded two or three times a year. Pruning and cleaning the trees also are recommended but are not always practiced. They have the desirable effect, it is said, of facilitating the entry of air and light into the crown of the cacao tree to increase flower development and pollination and to reduce conditions favoring disease. Pruning is first done when the plants are about 3 years of age for the purpose of developing a balanced crown and to prevent excessive growth in height. Thereafter, during each dry season a small amount of trimming is necessary to remove surplus branches. A few planters subject their trees to heavy pruning every third or fifth year. Occasionally, the more progressive planters disinfect the pruning wounds. Debris from weedings and trimmings is either removed from the field or windrowed. Manuring and fertilizing are rarely done, except in Ceylon and Grenada, British West Indies. Tillage and other soil-management practices are seldom employed.

PRINCIPAL DISEASES AND PESTS. - Cacao is plagued with diseases and pests. Witches'-broom (*Marasmius perniciosus*), found currently in Ecuador, Colombia, Venezuela, Trinidad, and Surinam, is one of the worst cacao diseases. It manifests itself in three forms: Hypertrophied vegetative shoots (brooms), hypertrophied flower cushions (star-brooms), and malformed or small round indurated fruits. No satisfactory means of combatting witches'-broom is known, except by developing trees resistant to it. It is also possible that in time new fungicidal treatments may be developed which will control the disease.

In the Gold Coast the principal disease is swollen shoot, a virus complex characterized by the swelling of the young shoots, mottled and often malformed leaves, systemic necrosis, and defoliation. The virus causing the disease has been found to be transmitted by mealy bugs (*Pseudococcus sp.* and *Ferrisian* sp.), the cacao Psyllid (*Mesohomotoma tessmanii*), and the cacao aphis (*Toxoptera aurantii*).

Investigations indicate that there are at least eight pathological strains of the virus, some of which will kill a tree within 2 years, whereas the others will apparently produce only leaf or stem symptoms. Swollen shoot also is found in Nigeria and the Ivory Coast. It has not thus far been observed in the Western Hemisphere, but a virus disease resembling the milder forms of swollen shoot has been reported in Trinidad.

Rogueing, or cutting out of infected trees, is the method of control used in West Africa. After the diseased trees are cut down, they are removed. They may be used for firewood or other purposes, since the infection dies with the tree.

Monilia pod rot (*Monilia* sp.) occurs chiefly in Ecuador but is reported also in Colombia and Venezuela. Black pod rot (*Phytophthora palmivora*) is prevalent in both West Africa and the Americas. Partial control has been effected through good cultural practices, including spraying. Other diseases, such as anthracnose (*Colletotrichum* sp.), brown pod rot and dieback (*Diplodia theobromae* Nowell), and sphaeronema pod rot (*Sphaeronema* sp.), may occur but are generally of minor economic importance.

Among the insect pests the most destructive are the capsid bugs (*Sahlbergella singularis* and *Distantiella theobroma*), the cacao beetle (*Steirastoma depressum*), and thrips (*Selenothripa* sp.). The capsid bugs are widespread in West Africa. They feed upon the shoots, stems, and pods of the trees and also deposit their eggs in these locations. It is believed that when the capsid bugs puncture the tree tissues they inject a toxic saliva, which is carried in the sap to all parts of the tree with the result that the leaves shrivel and fall off, and, in extreme cases, the tree dies. *D. theobroma* generally attacks young trees up to 6 years of age. *S. singularis* afflicts the mature trees. Spraying is effective against capsid attack, but it is not economical over wide areas because of the expense involved. A disease of the flower cushion, believed to be caused by mites, is common in the Rivas region of Nicaragua, the principal producing area. The symptoms are reduction in abundance of flowers and transformation of the cushions into galls, which may become as large as baseballs. Similar cushion galls have been observed in Costa Rica, Panama, and Colombia, but the causal organism is unknown.

HARVESTING. - Fruiting begins during the third or fourth year for Forastero and during the fifth or sixth for Criollo. Maximum production is reached when the trees are 10 to 15 years old and is maintained for about 20 years, depending upon soil, climate, and other conditions. Color is the usual criterion for determining ripeness. In some varieties the green color of the immature fruit changes to yellow or orange yellow. In others the reddish, immature pod turns to bright red or orange at maturity. When tapped, ripe fruits give forth a characteristic hollow sound.

The fruits are usually removed from the trunk with a cutlass (machete). On higher parts of the tree it is necessary to use a small specially made knife fastened to the end of a long pole. In Trinidad this implement is called a cacao hook, and in Ecuador, a podadera. Care is taken that only completely ripe fruits are picked, that clean wounds are made in harvesting, and especially that the fruit-bearing cushions are not injured.

About 80 percent of the world's crop is harvested from October to March and the remainder from April to September. The average production under good growing conditions and usual plantation management is about 350 pounds of dried beans per acre. (Approximately 400 dry beans weigh 1 pound.)

PREPARATION FOR MARKET. - After the fruits are picked they are cut open and the seeds scooped out by hand or with a spatula made of wood or bone. The seeds with their white, slimy coatings are then fermented. Fermentation methods vary from country to country and according to type of cacao. In general, fermentation of Forastero beans requires 6 or 7 days and of Criollo 3 days or less.

Planters have found that best results are obtained if the method of fermentation used permits retention of heat, free circulation of air, and drainage of liquids produced. Boxes meet these requirements best. They vary in size, ranging from about 4 to 6 feet square. They usually have perforated or slit bottoms and are placed a foot or so above the floor or ground. Beans are put in the boxes to a depth of about 2 feet. The boxes are kept in the shade or covered and the contents stirred at least once a day. Although box fermentation is generally considered the most satisfactory method, much of the world's cacao is fermented in more primitive ways.

Frequently in West Africa, the grower covers a well-drained piece of ground with plantain leaves and puts the wet cacao beans on the leaves in a cone-shaped pile. Then he covers it with plantain leaves, and lets the beans ferment 5 to 7 days without stirring. In the Dominican Republic and in Ecuador fermentation is more or less incidental. After the wet beans are taken from the pod, they are dried, and the only fermentation that occurs is during the drying process.

Fermentation is believed to be responsible for the development of the fine, characteristic aroma of chocolate, lessening of the bitter taste and astringency of the beans, and changing the color from purple or violet to brown or cinnamon. It also facilitates removal of the slime enveloping the beans and toughens the seed coat so that it is less likely to break during the drying process.

In some countries the fermented beans are washed before drying, but the general practice is to dry them, without washing, immediately after fermentation either by exposure to the sun or in artificial dryers. The loss of weight in drying is about 50 percent. The cured beans have a moisture content of 5 to 6 percent.

In sun-drying the beans are spread out thinly on a platform each day until thoroughly dried, usually about 7 days. To ensure even drying and a uniform color, the beans are turned over frequently during the day. At night, or when there are showers, the beans are covered. The drying floor varies in different countries. It may be of split bamboo laid on the ground, as in Ecuador, or made into platforms, as in Colombia. In Trinidad the floor may be of concrete, brick, or wood covered with palm matting. Light bamboo mats, either on the ground or on trestles, are used in Africa. Drying houses equipped with large, flat wooden wagons which run on rails occasionally are found. The ease with which the wagons may be pushed in or out of the drying house is a point much in their favor. Also permanent drying platforms with movable roofs have been erected on some plantations.

In a number of countries, including the Cameroons, Ceylon, Grenada, Panama, Brazil, San Thome, and Costa Rica, drying is done by artificial heat. This method has distinct advantages in regions where weather conditions are uncertain.

Frequently the beans are polished during the early stage of drying to remove adhering matter and to give them an attractive appearance. The beans are heaped into small piles and sprinkled with fresh water. Laborers then stir them briskly, or trample them in a dancing fashion with bare feet, for about an hour; hence, the term "dancing" cacao.

Most major producing countries have legislation providing for the inspecting and grading of cacao offered for export. Although the number of commercial grades varies among the countries, standards are set up generally for 3 or 4 grades. Some countries prohibit the export of cacao beans falling below the third grade.

As the United States is the principal importer of raw cacao beans, most countries base their commercial-grade specifications upon the minimum American requirements for entry as provided in the Federal Food, Drug, and Cosmetic Act of 1938. United States Government enforcement officials have announced that shipments of cacao will be detained if they contain moldy and wormy beans in excess of 10 percent, of which not over one-half, or 5 percent, may be moldy.

After the cured beans are graded, they usually are weighed into jute bags for export and appropriately stamped or marked. Bagging may be done on the plantation or at the warehouse of the broker. The weight of the bags varies according to country.

MARKETING PROBLEMS

Transportation

Cacao beans are transported to seaports in a variety of ways, depending upon the country. In remote, undeveloped agricultural regions, particularly parts of West Africa, natives still bring cacao to collection points in various kinds of containers carried on the head. In the Gold Coast payment is made on the basis of the headload - about 60 pounds. From collection depots, the beans commonly move to shipping points by rail or truck, although in some cases additional head porterage is necessary. In Ecuador, most of the cacao is transported to Guayaquil by river boats, canoes, and rafts, but railroads and trucks are used to some extent. Mules, boats, trains, and trucks are utilized in Brazil to move cacao to seaport. In Trinidad trucks are displacing the railway as a means of transporting the beans to market. In San Thome and Costa Rica railroads are the chief means of transport.

Owing to the lack of harbor facilities, it is often necessary to transport the bags of cacao from shore to ship by surf boats or lighters. Aboard ship, the beans are placed in dry compartments, and care is taken to keep insect infestation at a minimum.

The principal world ports for shipment of cacao are:

Country	*Port*	*Country*	*Port*
Belgian Congo	Matadi	Ecuador	Guayaquil
Brazil	Ilheus, Salvador (Bahia)	French Cameroons	Duala
Dominican Republic	Sánchez, Puerto Plata. Ciudad Trujillo	Gold Coast	Accra, Takoradi

Ivory Coast	Port Bouet	Trinidad	Port of Spain
Nigeria	Lagos	Venezuela	La Guayra, Carupano, Guiria, Puerto Cabello, Maracaibo
San Thome	San Thome		

Storage

Cacao beans deteriorate quickly under humid tropical conditions and for that reason are marketed as soon as possible after they are cured. The beans seldom are stored more than 4 to 8 months. Even then, it is frequently necessary to redry them before shipping. With about 80 percent of the world's supply being harvested between September and March, the problem of satisfactory storage is of great concern to all shippers.

During World War II restricted shipping facilities made it necessary to store cacao for greater lengths of time than usual. To assist shippers, agencies in several countries investigated methods of storage and made recommendations. In Nigeria, for example, the Department of Agriculture issued instructions concerning storage as follows:[1]

1. Stores had to be rainproof, light, and airy, with good concrete floors.
2. All stores and dunnage had to be thoroughly cleaned and whitewashed before the season began.
3. Cocoa stacks were to be as large as possible and bags were to be tightly packed. Three-foot alleyways had to be left between the stack and the walls of the store.
4. All necessary precautions had to be taken to keep insect infestation at a minimum.

The requirements for proper cacao storage in other countries are similar to those in Nigeria.

Methods of Marketing

Several methods of marketing are found in the various producing countries, of which the most common are (1) direct sale by producer, (2) by brokerage or middlemen, and (3) by cooperatives. Under the system of direct sale by producer, the farmer offers his cacao for sale on the local market, or sells directly to the exporter or his agent, thereby eliminating the middleman. This type of marketing is found in Ecuador and other countries with very large plantations. In countries where small individual holdings are the rule, West Africa for example, the direct-sale type of marketing is rarely found.

The brokerage system is the most common method of marketing cacao. It predominates in West Africa. The producer sells his cacao through either a local middleman or a traveling dealer. Some of the intermediary buyers represent large firms; others are independents who buy beans with their own capital and usually resell to exporters or brokers. A broker may have one or more subbrokers working for him.

The brokerage system may be very wasteful. Improper methods of handling the beans and lack of proper storage and transit facilities frequently cause excessive losses. As the beans may pass through the hands of several middlemen before reaching the shipper, the producer is likely to be paid a low price for his beans in order that each operator may make a profit.

[1] YOUNG, A. H. COCOA STORAGE IN NIGERIA. Rpt. and Proc. of Cocoa Res. Conf., Colon 1942, pp. 118-119. London. 1945.

The general economic objectives of cooperative marketing organizations are to obtain higher prices for growers, reduce production costs, improve quality, provide agricultural credit, and, in the case of West African farmers, to teach the value of thrift, mutual helpfulness, and self-help. Although cooperatives provide an excellent method of marketing and eliminate the evils and some of the complexities of the brokerage system, they have not been too successful, except in Trinidad and Brazil. The Trinidad Cocoa Planters' Association markets practically all the beans exported from Trinidad and Tobago. One of the functions of the Bahia Cocoa Institute is to promote the organization of cooperatives. In the Gold Coast a number of cooperatives exist, but they marketed only 3 percent of the total 1936-37 crop. Records on the percentage marketed in subsequent years are not available. Cooperatives also are found in Nigeria and Grenada.

Cooperative marketing seems to be handicapped primarily by a lack of understanding of the program by the farmers, particularly in West Africa, and the financial inability of the societies to make cash settlements upon delivery of the cacao. The majority of farmers, therefore, prefer to deal directly with brokers who make full settlement at the time of delivery. As banks, cooperatives have achieved a measure of success.

Government-controlled marketing

Brazil and British West Africa have placed marketing directly under Government control. These countries control approximately 70 percent of the world's supply of raw beans. There are many objections to government-controlled marketing. It eliminates free enterprise, which is the life blood of trade; deprives citizens of their rights to bargain; and, when improperly administered, restricts trade to desired channels and curtails consumption by increasing prices to uneconomic levels.

Brazil was one of the first countries to intervene in cacao marketing. The Instituto de Cacau da Bahia, A. A. (Bahia Cocoa Institute) was created as a cooperative society of limited responsibility by Decree No. 7430 of the Federal Interventor of Bahia, dated June 8, 1931. Its statutes were approved, and authorization to function was granted by Federal Decree No. 20677 of November 18, 1931. The objectives of the Institute, as defined in the act creating it, were as follows:

1. Promote the prosperity of the industry in Bahia.
2. Diffuse knowledge of modern techniques in the cultivation, preparation, and processing of cacao.
3. Carry on technical research in cacao.
4. Promote diversification of industry in the cacao zone.
5. Assist members in the acquisition of machinery, fertilizers, insecticides, and the like.
6. Make long-term loans to members, at moderate interest, secured on property, exclusively for farm development.
7. Make short-term loans to members to finance crops.
8. Organize statistics and information services concerning cacao at home and abroad.

9. Build and maintain cacao deposits appropriate for the conservation of the product and equipped for inspection, classification, and bagging; to serve as obligatory official warehouses for cacao destined for export.

10. Sell cacao consigned to it by members, collecting a 2-percent commission (later raised to 3 percent).

11. Organize commercial export types for Bahia cacao.

12. Promote the industrial use of cacao as dictated by the interest of the State.

13. Organize, where convenient, rural cooperatives to act as its branches or agencies.

14. Propose to the authorities permanent and emergency measures for the aid and development of the cacao industry.

15. Encourage, assist, or undertake the preparation of a census of the cocoa culture for the municipalities in the cacao zone.

16. Promote, by every available means, in the cacao zone a more efficient system of transport, rural education and hygiene, colonization, and the improvement of workers' living conditions.

The initial capital for the Institute was supplied by the Bahia State Government through a 10-million-cruzeiro loan from the Bank of Brazil. The proceeds from the tax of 2½ cruzeiros (about 12½ cents) per 132-pound bag, provided for in the decree establishing the Institute, were taken over by the Government to guarantee payment of the loan. On March 22, 1932, a loan of 50 million cruzeiros was obtained from the Caixa Economica de Rio de Janeiro out of which the 10-million-cruzeiro loan was paid outright. This enabled the Institute to use the cacao tax money for other purposes.

Federal Decree No. 11,861 of March 27, 1941, abolished the cooperative status of the Institute, transformed it into an autarchy, but did not otherwise affect the Institute's program or the cacao industry as a whole. Complete Government control came into effect on May 19, 1943, with the passing of a resolution which vested the purchase and sale of cacao solely in the Institute, eliminating all private exporters and cooperatives from the cacao trade. On April 30, 1946, the Brazilian Government terminated its wartime control of cacao, but subsequent resolutions again placed foreign sales of cacao under the exclusive control of the Institute. Private dealers and cooperatives are permitted to engage in domestic trade. Since the bulk of the production is sold abroad, the Institute is the most important factor in the buying and selling of cacao in Brazil. It buys cacao on consignment from the growers, making advances upon delivery and final settlement after sale of the product.

Government control in British West Africa dates back to 1939, when the British Government announced a marketing plan not only to purchase the entire British West African crop but also to fix prices to the producers and dispose of the cacao, acting as trustees for the producers. At first the cacao was purchased by the Ministry of Food but later by the West African Produce Control Board, created especially for this purpose.

On November 20, 1946, the British Government issued a White Paper, "Statement on Future Marketing of West African Cocoa," setting forth a plan for marketing British West African cacao beginning with the 1947-48 crop. In brief, the White Paper provides for the creation through local legislation (effected in March 1947) of two boards to be known as the Gold Coast Cocoa Marketing Board and the Nigeria Cocoa Marketing Board, the main functions of which will be: (1) To fix the seasonal prices payable to producers; (2) to determine purchase arrangements and issue licenses to buyers; and (3) to set up and maintain the necessary executive machinery for purchasing, shipping, and selling all cacao purchased.

The main functions of the Boards' licensed buying agents will be:[2]

1. Purchase of cocoa at prices not less than the seasonal minima announced.
2. Bag, arrange for grading, and report periodically to the Board the quantities purchased.
3. Provide proper storage and to be responsible for the maintenance of quality in accordance with regulations laid down by the Inspection Departments until shipment or delivery otherwise to the Boards.
4. As instructed by the Boards, to transport the cocoa to ports, to arrange for check weighing before shipment and place on board ocean vessels, and to produce shipping documents.
5. Finance the cocoa from the time of purchase to shipment, or delivery otherwise, to the Boards.

The Boards' initial funds will be provided from the surplus arising from the cocoa operations of the West African Produce Control Board.

The selling arrangements of the Boards remain to be worked out, but as envisaged they will jointly establish an organization in London to advise on the formulation of general marketing policy and to sell all cacao on their behalf. As long as cacao is subject to allocation by the International Emergency Food Council, the decisions of that body will govern the direction of sales.

IMPROVEMENT PROGRAMS

Many producing countries have undertaken cacao-improvement programs. In general, these programs provide for the following lines of endeavor:

1. Rehabilitation of old cacao stands and planting new areas.
2. Disease and pest control.
3. Improved plantation-management practices.
4. Selection and development of disease-resistant, high-yielding trees for new plantings and replacement of inferior trees.

Emphasis is placed upon finding new planting stock derived from cultivated, or wild ancestral, trees with the desired characteristics to resist the various diseases and

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[2] [Great Britain] Colonial Office. STATEMENT ON FUTURE MARKETING OF WEST AFRICAN COCOA. [Gt. Brit.] Colon. Off. Cmd. 6950. 8 pp. London. 1946

insects attacking cacao and with the ability to adapt to new areas of cultivation. As yet, research along this line has not gone beyond the preliminary stage in any country.

The variability exhibited among cacao seedlings makes propagation from seed impractical. To eliminate variability and to propagate desirable qualities, such as disease resistance, horticulturists have turned their attention to propagation by vegetative methods, that is, grafting, budding, and cuttings. Of these methods, the use of rooted cuttings appears to be the most satisfactory.

For a long time it seemed that cacao trees could not be propagated on a commercial scale from cuttings. However, the Imperial College of Tropical Agriculture developed a procedure for obtaining rooted cuttings. Suitable branches are removed from selected trees, and their basal ends are treated with a growth-promoting substance before being placed in a shaded propagating bin for rooting. The cuttings root in 3 to 4 weeks and then are transferred to baskets, or pots, and put in hardening bins. The process of hardening, which requires about 2 weeks, consists of gradually reducing humidity and increasing light intensities. The potted plants are taken from the bin to a sheltered shed where the process of hardening is completed. They are then ready for distribution.

British Colonial Empire

TRINIDAD. - Early in the present century, the Government of Trinidad directed its Department of Agriculture to undertake programs designed to increase cacao production. Much information relating to cultural practices, such as yield, pruning, spacing, and fertilizing, was obtained. Fundamental cacao research, however, involving plant breeding, mycology, pathology, and propagation, was initiated in 1929 by the Imperial College of Tropical Agriculture. One hundred selections of high-yielding cacao trees were established at Rivers Estate for study and later utilization in a rehabilitation program. This was the first cacao-research program in any producing country.

As a result of the rapid spread of witches'-broom disease in 1933, the research program was focused on its control, with emphasis on the selection of disease-resistant stock. Toward this end, expeditions were sent to countries plagued by the disease, and much material was introduced, the most promising of which was brought from Brazil's Amazon River Basin. Disease tests are still incomplete, and no definite conclusions have been made concerning the relative value of the selections.

The best of the 100 selections of cacao made on a performance basis are now being propagated vegetatively for use in the cacao rehabilitation program of the Department of Agriculture. Some of these are producing more than 1,000 pounds of dry cacao beans per acre. The rehabilitation program provides for replanting approximately 10 percent of the land suitable for cacao and for the payment of subsidies to the farmers for replanting at a spacing closer than 12 feet. Approximately 400,000 rooted cutting will be needed over a period of several years for the program. To provide the required number, 200 propagating bins have been constructed.

GRENADA. - To improve its cacao industry, the Government of Grenada announced a plan to rehabilitate about 10,000 acres of the most suitable cacao-producing land. Funds were made available for studying methods of rehabilitation and assisting growers in the commercial application of the results of the research. Approximately 79 cacao selections have been made, but only 4 or 5 of the best will be used in the replanting program. By simply replacing the old cacao trees with superior-yielding selections, production will, according to estimates, be increased by 20 percent within 10 years.

GOLD COAST. - With the establishment of the Central Cacao Research Station at Tafo, cacao research in the Gold Coast was inaugurated in 1938. In January 1944, this station was reorganized and expanded into the West African Cacao Research Institute. Four principal lines of work are provided - entomology, botany and pathology, chemistry and soil sciences, and agronomy. Immediate attention is being given to control of swollen-shoot disease and capsid bugs.

The control method recommended for swollen-shoot consists of cutting out the infected trees and replanting immediately. Selection of virus-resistant cacao trees also is being made. Three methods of controlling capsids are being explored - use of chemicals, natural predators and parasites, and resistant selections of cacao.

The Gold Coast Department of Agriculture is cooperating with the West African Research Institute in the swollen-shoot campaign. Recently, a new section of the Department was created, called the Cocoa Survey Section, which is charged with the responsibility of conducting a survey of the cacao industry and taking measures to control and prevent further outbreaks of the disease. The section will also be in charge of cacao planting in both devastated areas and new areas. In order for the farmers to see that areas destroyed by virus can be replanted, the Department has established a number of demonstration plots.

NIGERIA. - The Nigerian Department of Agriculture has been engaged in the improvement of cacao for several years and has done considerable work in breeding and selecting cacao. The Department is now conducting a survey of Nigeria and the British Cameroons, for the following purposes:

1. Obtain information concerning diseases and pests of the country, particularly swollen-shoot and capsids.

2. Record the location and extent of cacao areas.

3. Ascertain the present status of the industry and possibilities for expansion.

4. Study the economics of the industry.

5. Continue propaganda and instructions on control of the disease known as black pod.

BRITISH COORDINATED RESEARCH PROGRAM. - With cacao research being conducted in several parts of the colonial dependencies, it became apparent to the British Government that these programs should be coordinated under a single committee. For this purpose a Cocoa Research Committee was appointed. A cacao-research conference was held in London in 1945, with representatives from all the main producing regions of the Empire. The purpose of the conference was to discuss the entire field of cacao research and to assign work to the various British research institutes or other institutions of Government or industry.

This coordinated program is being financed from the profits accrued by the West African Produce Control Board and contributions from various English chocolate manufacturers. Provision is made in the British coordinated program for close collaboration between British Research Institutes and French and Belgian authorities in neighboring West African colonies. The way is open also for cooperation with non-British agencies conducting cacao research in other parts of the world.

American Republics

COLOMBIA. - Cacao research in the Republic of Colombia is centered at the Palmira Experiment Station, in the Departamento de Valle del Cauca. Although the scheme advanced by the Government emphasizes the establishment of new plantings in the country, provision is made also for a rehabilitation program. This plan calls for establishing 27,710 additional acres of cacao over a period of 5 years. This will require approximately 6,000,000 trees at an estimated cost of $130 per acre. In the Valle del Cauca it is estimated that 4 million trees will be sufficient to rehabilitate the worst of the diseased areas.

To supply the planting material required for the rehabilitation program, the Government has embarked on a selection and propagation program.

Approximately 500 selections have been made, of which many are being multiplied vegetatively for comparative yield trials and disease-resistance tests. In order that the industry may be rehabilitated with a high-quality type of cacao, similar to that which formerly characterized Colombia, an effort is being made to obtain Criollo and near-Criollo types. These types have the advantage of the hardiness of Forastero in addition to possessing the characteristics of Criollo. An extension service is also provided in the program to furnish technical supervision for the improvement of plantations.

The investigational work at Palmira, Colombia, has additional importance in that it is the only cacao research in the world being conducted at 3,000 feet above sea level.

Research on cacao is also being conducted in the States (Departamentos) of Magdalena and Huila.

ECUADOR. - Ecuador has been interested in cacao improvement for many years and has initiated several projects to increase production through cultural practices, such as spraying, fertilizing, and pruning, which unfortunately were discontinued, primarily because of insufficient funds. In 1943 a national cacao-research program was organized at the Cooperative Agricultural Station in the coastal lowlands near Guayaquil. This station is operated jointly by the Governments of Ecuador and the United States through the Office of Foreign Agricultural Relations, United States Department of Agriculture.

During 1943 funds were made available by the Ecuadoran Government for a survey of the cacao industry and to locate superior trees. Approximately 500 such trees were located and are now being increased vegetatively for extensive testing against witches'-broom and Monilia pod rot. Other investigational work being undertaken consists of studying the shade requirements of mature and seedling cacao, methods of propagating cacao, and methods of rehabilitating existing plantations and determining the optimum spacing of the trees. A reference collection of all available cacao types and species for plant-breeding purposes is being established.

VENEZUELA. - Rehabilitation of cacao in Venezuela dates back to 1940, when the Government initiated a program in the State of Sucre to prune and clean cacao plantations which were damaged by a hurricane in 1933. Recently the Government began a cooperative program with the growers in the Barlovento District of the State of Miranda to improve both production and quality of cacao marketed through a carefully planned rehabilitation scheme. Provision is made for technical assistance in cultural practices and for furnishing fermentation and drying equipment to the growers at a nominal price. In 1945 the Government began a selection and propagation program with the work being centered at Ocumare de la Costa.

To assist in controlling witches'-broom, the Government passed a law June 4, 1942, prohibiting the movement out of the State of Sucra and the Federal territory of Delta Amacuro of cacao plants, fruits, earth, and of sacks and other containers used for cacao.

BRAZIL. - Cacao investigations were initiated in Brazil in 1931 with the establishment of the Instituto de Cacau da Bahia. Much effort has been placed on selection. A white-seeded mutation has been found which research workers hope will provide high-quality planting stock.

Studies to control Phytophthora pod rot have been under way since 1938 and indicate that bordeaux mixture (1 percent) may be applied profitably where fruit losses exceed 15 percent. During 1944-46 a campaign was undertaken to control the Enxerto ant (*Azteca paraensis* var. *bondari*), the worst insect pest of cacao in Brazil, and about 10 million colonies were destroyed.

Cacao improvement is also being conducted at the Instituto Agronomico do Norte in Belem. There a cacao collection of commercial types, as well as of various species, is being assembled.

MEXICO. - Cacao research in Mexico is centered at Tapachula, in the southern part of the country. A number of outstanding trees (Criollos and Forasteros) have been selected and are now being propagated vegetatively. Investigations to improve cultural practices are also being undertaken. This program is financed by the profits accrued to the Government in its price control of cacao.

COSTA RICA AND PANAMA. - Cacao improvement in the Republics of Costa Rica and Panama is being done chiefly by the United Fruit Company at Quepos, Costa Rica, and Almirante, Panama. The program consists of three phases:

1. Selection of superior trees for propagation and utilization of the plantation.

2. Rehabilitation of old plantings and establishment of new ones with selected stock.

3. Conduction of spraying experiments to control Phytophthora pod rot. An investigation of the effects of fertilizing on production is also contemplated. Studies of better plantation management and harvesting practices indicate that the production of raw cacao beans per acre may be increased as much as 100 percent in old plantations and, with spraying, from 200 to 300 percent.

Approximately 15 selections have been made, of which all are being increased for field planting. About 1,000 acres have been planted with selected stock. Recently General Foods Corporation, in cooperation with the United Fruit Company, set up a pilot plant in Almirante, Panama, to study methods of improving the curing of cacao beans.

Although resolutions have been passed by the various Inter-American Agricultural Conferences since 1930, providing for concerted action in improving production and for establishing cacao-research centers, action was taken only in May 1947. During this month a Cacao Commission was established by the Inter-American Social and Economic Council of the Pan American Union and entrusted with carrying out the over-all cacao-improvement program of the American Republics. An Inter-American technical

committee on cacao, comprised of experts on production and processing, was appointed to formulate research plans and to function in an advisory capacity to the Cacao Commission.

At its first meeting, held at the Inter-American Institute of Agricultural Sciences in Costa Rica (September 30 - October 4, 1947), the Inter-American Technical Committee on Cacao resolved that the objectives of the Inter-American improvement program were to further economic production of cacao in the Western Hemisphere for the increased welfare of producers and consumers. Through this Technical Committee the independent programs being conducted in different cooperative countries are coordinated to facilitate the interchange of information and disease-free plant material and to accelerate production by cultural practices and development of cacao trees superior in disease resistance, quality, and yield. This program, as well as the headquarters of the Technical Committee, will be centered at the Inter-American Institute of Agricultural Sciences, a cooperative project of the American Republics.

Recently the American Cocoa and Chocolate Manufacturers Association, through its affiliated organization, the American Cocoa Research Committee, entered into an agreement with the Inter-American Institute of Agricultural Sciences to undertake basic research on cacao and to establish a training program for technicians. Scholarships are available to both North American and Latin American students.

OUTLOOK

The outlook for the cacao grower is more favorable today than it has been for nearly two decades. Prices are the most remunerative in years. The immediate problem is no longer overproduction but rather underproduction. The future prosperity of the industry depends largely upon finding ways of increasing production in line with world consumption and stock requirements and on price stability. It also depends to some extent upon the success of the Pan American Union and the British Government in their respective spheres of influence to coordinate the independent cacao-improvement programs of the various producing countries into united cacao-research fronts. If an economic balance can be achieved and maintained between production and consumption, the industry will prosper; otherwise, periods of depression are almost inevitable.

Although at the present time overproduction appears rather remote, attention should be given to this possibility and plans for expansion made accordingly. However, the emphasis in the system of cacao farming should be redirected. Extensive cultivation must give way to intensive cultivation if cacao is to be obtained at less cost. In other words, cacao should be handled as an orchard crop rather than as an exploitative crop.

The two methods of augmenting production are increasing yield per tree and extending the acreage. Increasing the yield per tree may be accomplished to a great extent by practicing approved cultural methods, by closer harvesting, and by controlling diseases and pests. Significant progress in this direction, however, is contingent upon the development of high-yielding, disease-resistant varieties with which to replace unsatisfactory trees. Among the factors to be considered in extending cacao acreage are type of soil, climatic conditions, diseases and pests, labor supply, transportation facilities, and ability of the market to absorb the new production.

Since the demand for cocoa and chocolate products is relatively elastic, attention should be given to the effects of government-controlled marketing, internal taxes, and import duties on consumption. The economic status of the various consuming

countries and the extent to which their populations will be able to purchase cocoa and chocolate products also are points for consideration in any program looking toward increased production.

The time is propitious for both producing and consuming countries to cooperate on cacao-improvement programs, with a view to bringing production and consumption into balance. The consumer will use more cacao if adequate supplies within his means are available; the grower will prosper if he can dispose of all his crop at a reasonable profit.